Precipitation over the Southern Ocean: ERA5 and PWRF/AMPS evaluation during two snowfall events around Mertz Glacier

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• Important polynya system in this region
• Big contributor to the Antarctic Bottom Water (AABW) formation
• AABW plays a major role in the global ocean overturning circulation
• Thus, is a critical component of the climate system
Motivation

• AABW production is controlled by surface salinity, which is highly sensitive to freshwater input.

• Key contributions to freshwater input are melting of the ice shelves, sea ice and precipitation.

• Increased precipitation, as part of the enhanced global hydrological cycle, is expected to have a greater impact on the freshening of the ocean and is still highly uncertain.

• Precipitation is a poorly known variable in the region due to the lack of measurements.
Antarctic Circumnavigation Expedition (ACE)

• December 2016 - March 2017, on board icebreaker-type research vessel “Akademik Tryoshnikov”

Akademik Tryoshnikov nose-in to ice shelf in Mertz Polynya
Photo from: ACE report, Walton and Thomas (2018)
**DATA**

**PRECIPITATION MEASUREMENTS:**
- **Snow Particle Counter (SPC)** aboard ACE ship (only 2-3 Feb event)
- **Micro Rain Radar (MRR)** aboard ACE ship (only 2-3 Feb event)
- **MRR** in Dumont D’Urville (DDU) station (66.66°S, 140.00°E) (both events)

**REANALYSIS/MODELS:**
- ECMWF’s **ERA5 reanalysis** product (both events)
- **AMPS** (Antarctic Mesoscale Prediction System using Polar-WRF model) (only 2-3 Feb event)

**RADIOSONDES:**
- **ACE** ship (only 2-3 Feb event)
- **DDU** station (both events)
2-3 February event

LEGEND:
- Yellow triangle – ACE ship position
- Green star – DDU location
- Cyan line – Cold front
- Red line – Warm front
- Magenta line – indefinite type of front

Total Precipitation (mm) + MSLP (hPa) - 2017-01-31 06:00 UTC
- Extratropical cyclone **east** of Mertz region
- Easterly, **moderate** and along shore moisture transport
- Precipitation hits the ACE ship first and DDU later

2-3 February event
- **Snowfall** on ACE ship and DDU
- ERA5 precipitation type match with meteorological observations on the ship and DDU
- ACE ship at the boundary between dry and wet snow, according to ERA5
2-3 February event

- ERA5 **overestimates** peak of precipitation at the ACE ship position, and **underestimates** the peak at DDU
**2-3 February event**

**PWRF/AMPS DOMAINS:**
- Domain 1 -> 30 km resolution
- Domain 2 -> 10 km resolution

- ERA5, PWRF/Domain 1 and PWRF/Domain 2 have **similar results** at ACE ship position
  - **Both** ERA5 and PWRF **overestimate** snowfall compared to observations
8-10 February event

LEGEND:

- Yellow triangle – ACE ship position
- Green star – DDU location
- Cyan line – Cold front
- Red line – Warm front
- Magenta line – indefinite type of front
8-10 February event

- Extratropical cyclone **west** of DDU/Mertz
- Cyclone **blocked** by a high-pressure ridge
- **Intense** northerly moisture transport (identified as an **atmospheric river** by Gorodetskaya et al. (2020) algorithm)
ERA5 precipitation type shows **only snowfall** in DDU during this event, as observed in the station.
• Occurrence of virga between 5:00 and 15:00 UTC, 8 February and from 11:00 to 18:00 UTC, 9 February (Jullien et al., 2020)

• ERA5 overestimates snowfall during this event
2-3 February event

8-10 February event
Conclusions

- **Caution is needed** in the use of ERA5 (reanalysis in general) precipitation data in this region:
  - ERA5 seems to simulate reasonably well precipitation spatial patterns and precipitation type;
  - Differences in precipitation amount when compared with observations;
  - Difficulties in modelling precipitation sublimation (virga) over katabatic flows.

- PWRF/AMPS has similar results to ERA5 in the analysed event.

- ERA5 captures reasonably well vertical profiles compared to radiosondes in both events, but overestimate IVT and IWV in the weaker event and underestimates in the intense event.
References


Data used:


Thank you for your attention!

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